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ANTICOAGULANT COMPOSITION

## FIELD OF THE INVENTION

5           The present invention relates to an oral heparin tablet composition, a corresponding tablet, and to corresponding methods of manufacture.

## BACKGROUND OF THE INVENTION

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Heparin, whether normal (native, not fractionated) or partially degraded (fractionated), is an important anticoagulant. It is administered to persons with increased risk for blood clot formation, such as persons having  
15 undergone surgery or severe trauma or whose blood coagulation system is not well balanced, such in persons with risk for deep venous thrombosis. The drawback with this cheap and efficient drug is the requirement of administration by injection.

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## OBJECTS OF THE INVENTION

It is an object of the invention to provide an oral heparin tablet composition that exploits the advantageous  
25 properties of lipids as pharmaceutical carriers in regard of gastrointestinal uptake and/or sustained release and/or convenience and/or economy.

It is another object of the invention to provide a corresponding carrier composition for incorporation of  
30 heparin.

It is a further object of the invention to provide processes for making the aforementioned carrier composition and for incorporating heparin into said carrier composition.

Further objects of the invention will be evident from  
35 the following short description of the invention, the

description of preferred embodiments, and the appended claims.

#### SHORT DESCRIPTION OF THE INVENTION

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According to the present invention is disclosed a solid heparin composition for oral administration which has a melting point of from 25°C to 50°C or more, preferably from 30°C to 45°C, more preferred from 33°C to 42°C, comprising a continuous lipid phase comprising, preferably consisting of, a polar lipid component, a non-polar lipid component, and a pharmacologically efficient amount of heparin which may be native (non-degraded) or degraded (fractionated) heparin. The polar lipid component consists of one or more polar lipids. The non-polar component consists of one or more non-polar lipids. The one or more polar lipids are membrane lipids, in particular glycolipids and phospholipids. The one or more non-polar lipids are preferably glycerides, i.e. glycerol esters of fatty acids (mono-, di-, and triglycerides). All polar and non-polar lipids of the invention can be sourced from foodstuffs or food grade material. The polar lipids of the invention are amphiphilic with headgroups such as galactose or phosphate esters. The polar lipid component of the invention is combined with the non-polar lipid component in various proportions to allow the controlled incorporation of pharmaceutical including food supplement agents. It is believed that the incorporation mechanism is based on interactions of the polar headgroups and the lipophilic chains of the non-polar component with the compound to be incorporated. Pharmacologically efficient compositions for heparin, optionally in admixture with other pharmacologically active agents, can be experimentally determined by varying the ratio of the polar to non-polar component. To a certain extent the pharmacological efficacy of the composition is

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also influenced by the composition of the polar and non-polar component, respectively.

Preferably the polar component of the solid heparin composition according to the invention comprises or, more  
5 preferred, consists of one or several polar lipids of vegetable origin, such as oat kernels or soybeans. Preferably the non-polar lipid component of the composition according to the invention comprises or, more preferred, consists of one or several glycerides of vegetable origin, such as palmkernel  
10 oil, coconut oil, palm oil and cottonseed oil.

It is particularly preferred for the solid heparin composition of the invention to comprise lipid material of vegetable origin only.

According to the present invention is also disclosed  
15 a solid heparin oral tablet produced from the aforementioned pharmaceutical or food supplement composition, in particular by compression moulding or casting.

In the pharmaceutical literature lipid continuous phases are described as oily liquids, which need to be  
20 administered as oral liquids or enclosed in hard or soft shell capsules. However, such oily liquids are completely outside of the scope of the present invention. Lipid phases are also known in form of dispersions, i.e. dispersed aqueous solvents. Lipid emulsions and liposome preparations are  
25 examples of such dispersions which, by definition, are not lipid continuous phases and therefore do not form part of the present invention.

The polar component of the invention can be described as formed of membrane lipid(s), i.e. the lipid constituents  
30 of biological membranes. Membrane lipids contain a polar, hydrophilic, head group and one or more lipophilic hydrocarbon chains. This combination makes the membrane lipid molecules amphipathic and enables them to associate both with water and oils. Such membrane lipids can be classified  
35 according to their chemical structure, which is a function of

how the polar head group is linked to the lipophilic chains. Sphingolipids (linked by sphingosine) and glycerolipids (linked by glycerol) are the two main groups. Depending on the characteristics of the polar head group sphingolipids and glycerolipids can be further classified as phospholipids, with the head group being a phosphate ester, or as glycolipids, with the head group being a carbohydrate. Depending of the specific nature of the carbohydrate group membrane lipids sometimes are called, for example, galactolipids, which are glycerolipids with galactose in the polar head group. Examples of common membrane lipids are phosphatidylcholine (PC), phosphatidylethanolamine (PE), and digalactosyldiacylglycerol (DGDG). The membrane lipids can be extracted from, for example, egg yolk (egg lecithin), milk and dairy products, soybeans (soy lecithin), other oil crops, oat kernels, and other cereals and grains. These extracts can be further treated to become, for example, PC from soybeans and galactolipids from oats. Preferred polar lipids are galactolipids from oat kernels (CPL-galactolipid) or from soybeans (soy lecithin or soy-PC).

Synthetic polar lipids and membrane lipid analogues based on a carbohydrate or phosphate ester moiety are comprised by the polar lipid component of the invention.

The preferred non-polar lipids of the invention are fatty acid esters of glycerol. These esters include mono-, di-, and triglycerides. Edible oils are triglyceride oils, from which mono- and diglycerides can be derived. Other non-polar lipids of the invention include vegetable and animal oils from various sources, synthetic oils, fatty acids, natural and synthetic glycerides, sterol esters, fatty alcohols. Synthetic non-polar lipids and fatty acid analogues are also comprised by the invention. A description of the area of polar and non-polar lipids is given in "Fatty Acid and Lipid Chemistry" (Frank Gunstone, 1996, Blackie Academic & Professional, Chapman & Hall).

The triglyceride may be selected from palmkernel oil or natural oils with similarly, relatively high solid fat content or melting range. Preferred non-polar lipids include palmkernel oil fractions, obtained by commercial fractiona-  
5 tion of palmkernel oil into specific mixtures of triglycerides, e.g. palmkernel stearin, based on the combination of mainly lauric, myristic, and palmitic esters of glycerol. Preferred monoglycerides are selected from edible oil derived monoglycerides, in particular medium chain  
10 monoglycerides (chain length  $C_8 - C_{10}$ ), derived from coconut oil, and normal chain monoglycerides (chain length  $C_{16} - C_{18}$ ), derived from most vegetable oils.

According to a preferred aspect of the invention the continuous lipid phase may comprise up to 15% by weight,  
15 preferably up to 10% by weight, most preferred up to 5% by weight of water and/or an alcohol, including a alkanediol or -triol, such as ethanol, 1,2-propylene glycol, low molecular weight polyethylene glycol, and glycerol. By definition the continuous lipid phase cannot comprise more water or alcohol  
20 than is compatible with its property of being continuous.

According to the invention is also disclosed a carrier composition for heparin consisting of a continuous lipid phase having a melting point of from 25°C to 50°C or more, preferably from 30°C to 45°C, more preferred from 33°C  
25 to 42°C, comprising, preferably essentially consisting of, a polar lipid component in combination with a non-polar lipid component.

According to the present invention is furthermore disclosed a process for the production of a heparin tablet  
30 composition which has a melting point of from 25°C to 50°C or more, preferably from 30°C to 45°C, more preferred from 33°C to 42°C, comprising a continuous lipid phase comprising, preferably consisting of, a polar lipid component, a non-polar lipid component and native (essentially non-degraded)  
35 or fractionated (degraded) heparin, comprising mixing a polar

lipid component with a non-polar lipid component at a first temperature at which at least one of said components is in a liquid state, thereby obtaining a liquid continuous lipid phase, dissolving a pharmacologically effective amount of heparin in the liquid continuous lipid phase, cooling the solution thus obtained or aliquots thereof to a second temperature at which it solidifies, said second temperature ranging from 25°C to 50°C or more, preferably from 30°C to 45°C, more preferred from 33°C to 42°C. The cooling may produce a cake if carried out in bulk or a powder if the liquid product is fed to a nozzle, preferably at a temperature slightly above its melting point, and sprayed on, for instance, a cooled metal surface, in particular a polished chromium plated stainless steel surface in form of a band running on rollers. A powdery product may also be obtained by spraying the liquid product into an atmosphere of a temperature below the solidification temperature of the liquid product. The cake may be transformed into powder by, for instance, grinding at a low temperature.

According to a second preferred aspect is disclosed a heparin tablet of the invention coated with one or several layers of tablet coating excipients, such as to provide the tablet with an enteric coat and/or a coat physically stabilizing the tablet at a temperature at or above its melting point, and a corresponding coating process. Particularly preferred is a tablet of the invention provided with a first or only coat applied by a dry coating process comprising mechanically working a coating powder into the surface of the tablet at a temperature at which the tablet is sufficiently soft for the powder particles to adhere and allow them being worked into its surface but not sufficiently soft for substantial deformation, in particular at a temperature from 25°C to 10°C below the melting point of the tablet. One or more additional layers may be added to the thus coated tablet by routine pharmaceutical coating

processes known in the art. The tablet of the invention may also be built up around an inert nucleus.

A tablet according to the invention can be produced from the heparin oral tablet composition of the invention by  
5 compressing the aforementioned powdery product or by moulding or any other suitable process. According to a preferred aspect of the invention the moulding is carried out in a mould covered with an anti-adhering agent or layered

By way of examples it was surprisingly found that the  
10 solid heparin oral tablet composition of the invention increases the uptake of heparin in the gastrointestinal tract and/or prolongs its efficacy.

In the following the invention will be explained in more detail by the following, non-limiting examples.

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#### DESCRIPTION OF PREFERRED EMBODIMENTS

**Materials.** The lipid materials used are listed in Table 1.

20 **Table 1. Lipid materials**

Trade name and source
Galactolipids from oats (CPL-Galactolipid; Lipid Technologies Provider AB, Karlshamn, Sweden)
Medium chain monoglyceride (Akoline MCM; Karlshamns AB, Karlshamn Sweden)
Palmkernel stearin (fraction of palmkernel oil ; Karlshamns AB, Karlshamn Sweden)
Heparin (low molecular weight; Calbiochem, p.no. 375097)
Hydrogenated cotton seed oil (Akofine NF; Karlshamns AB, Karlshamn Sweden)

**EXAMPLE 1.** Preparation of a tablet by casting molten lipid mixture into a mould.

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Tablet ingredients (in g) are shown in Table 2.

**Table 2. Tablet composition**

Tablet preparation	A	B	C	D
Heparin*	0.08	0.18	0.21	0.0
Water	0.40	0.90	0.70	0.70
Monoglyceride	0.92	0.90	0.72	0.70
CPL-Galactolipid	1.24	2.79	2.17	2.17
Palmkernel stearin	1.40	3.15	2.31	2.52

\*Low Molecular Weight Heparin (LMWH)

The ingredients were blended and the mixture melted  
5 by heating to a temperature of 60 C and stirred at this  
temperature for 5 hours when all heparin had dissolved.  
Aliquots (0.24 g) of the melted phase were cast in a mould  
covered with hydrogenated triglyceride (Akofine NF™) powder.  
The mould was cooled in a freezer and the tablets recovered.

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#### **EXAMPLE 2. Animal study.**

NZW rabbits were used in all experiments and tablets were  
administered orally. The animals were given four or six  
15 tablets followed by water until they had swallowed the  
tablets. The animals were deprived of food for about 18 hours  
before dosing. Blood samples were drawn from the ear veins in  
sodium citrate vials before dosing and ½, 1, 4, 6, and 8  
hours after dosing for determination of APTT (Activated  
20 Partial Thromboplastin Time) on an IL Coagulation Systems ACL  
2000 apparatus. The blood samples were centrifuged for 10  
minutes at approximately 1270 G to obtain plasma for the  
analysis.

25 The results expressed as % change from baseline were  
individually calculated for each animal. The APTT value in  
the blood sample taken prior to dosing is regarded as  
baseline for each animal. The results are shown in Table 3.

**Table 3. APTT measurements in rabbits**

Tablet Preparation (LMWH IU/kg)	Time after dosing (hours)							No. of animals
	0	0,5	1	2	4	6	8	
A - 475	0	47	51	63	-5	35	8	3
B - 700	0	-9	51	23	35	26	-14	4
C - 1000	0	30	39.5	47	42.5	57	52.3	3
D - 0	0	-15	4	6	-22	-9	-5	7